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(71) Applicants
Esco Metallwaren Martin Hühnken,
7 Rudolf-Diesel-Strasse,
2072 Bargteheide,
Germany.
(72) Inventors
Bruno Ghibely
(74) Agents
Arthur R. Davies,
54 New Cavendish Street,
London, W1M 8HP.

(54) Circuit arrangement for an electric drive-in apparatus

(57) A magnet coil (10) is connected to a power source by a power switch (11) controlled by a control stage (14). The control stage (14) has a key (13) connecting it to the a.c. voltage and is itself responsive to an auxiliary control stage (16) including a zero-crossing detector (17) which transmits an auxiliary control pulse in phase with the a.c. voltage to the control stage (14) at or near the zero crossing of the a.c. voltage. The control stage (14) can delay the operation of the power switch (11) relative to the auxiliary control pulse by means of a time delay stage (15), thus providing an output of a fraction of a single half wave. Hence the power of a single impulse of the magnet coil can be reduced. Applied to a nailing or stapling machine, this allows reduced force to be used with delicate materials.

F I G.1

F I G.3

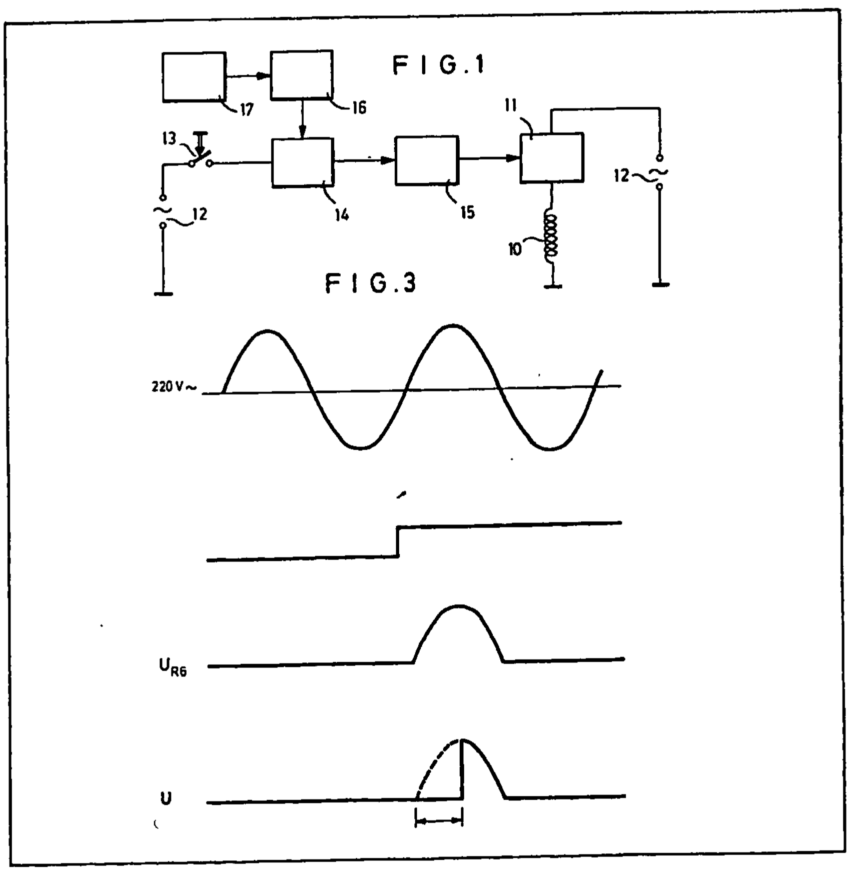

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FIG.1

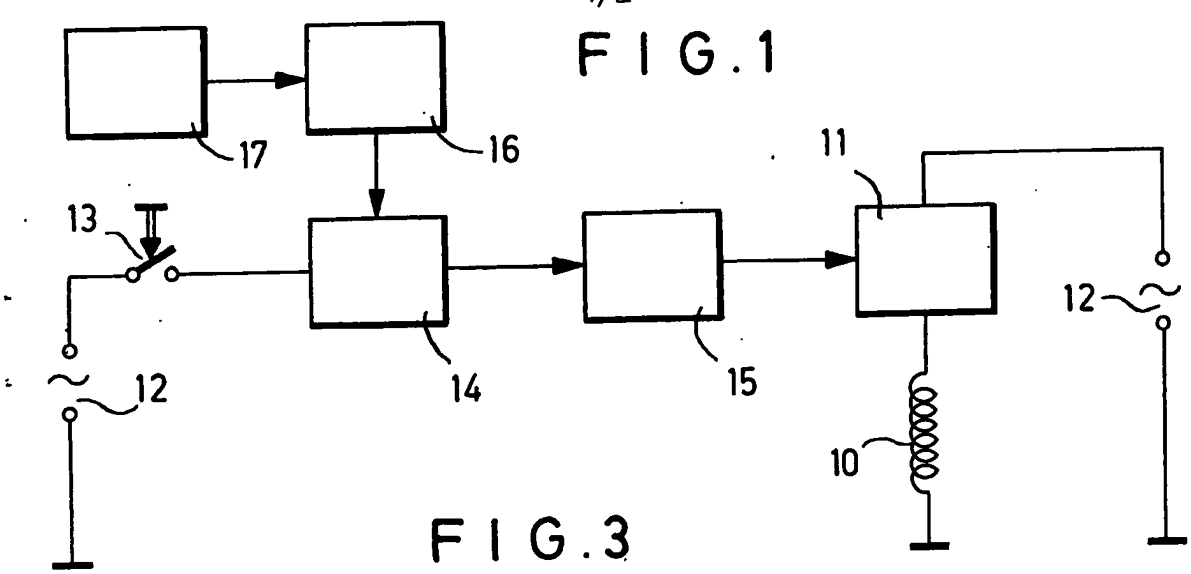
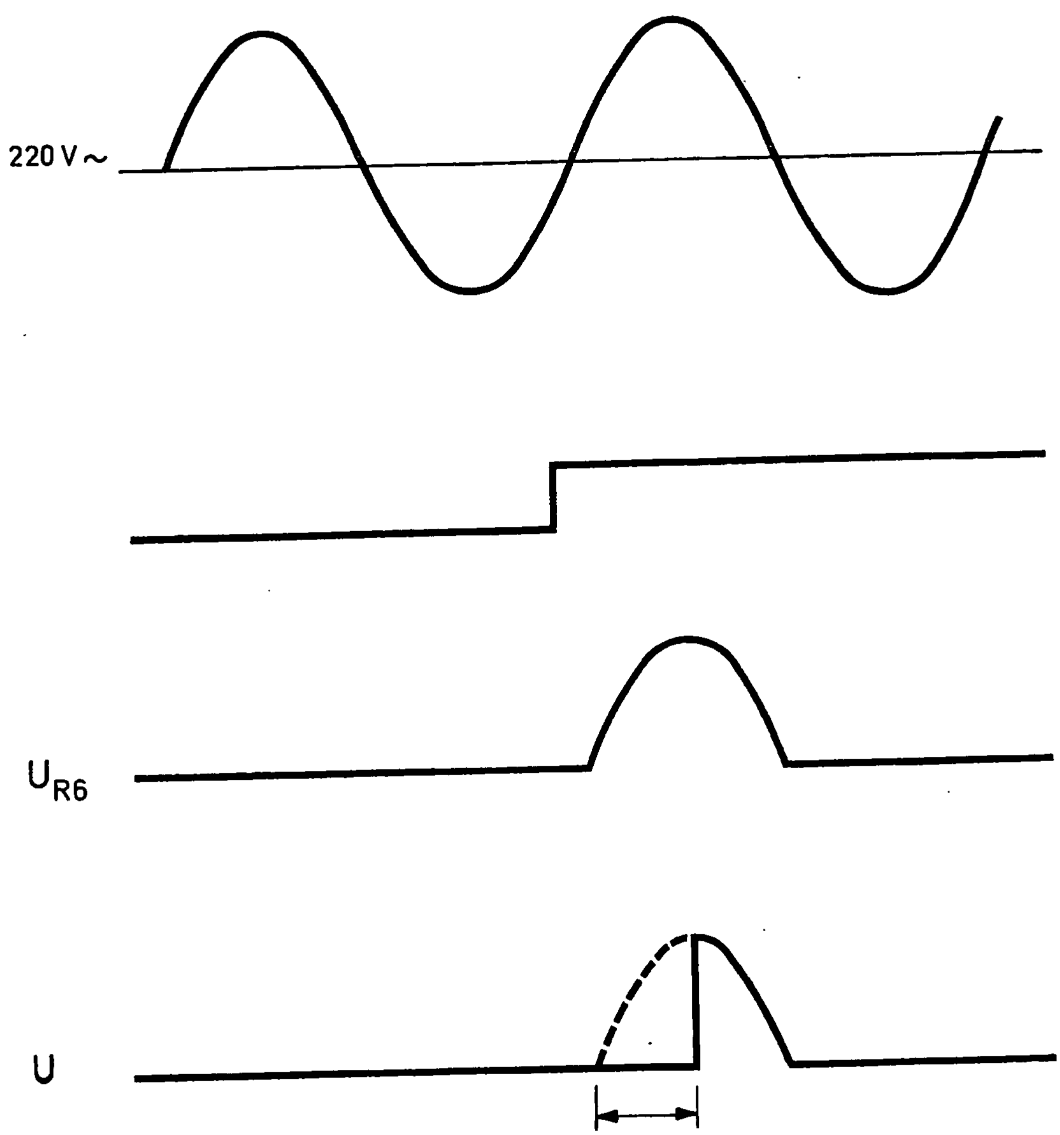
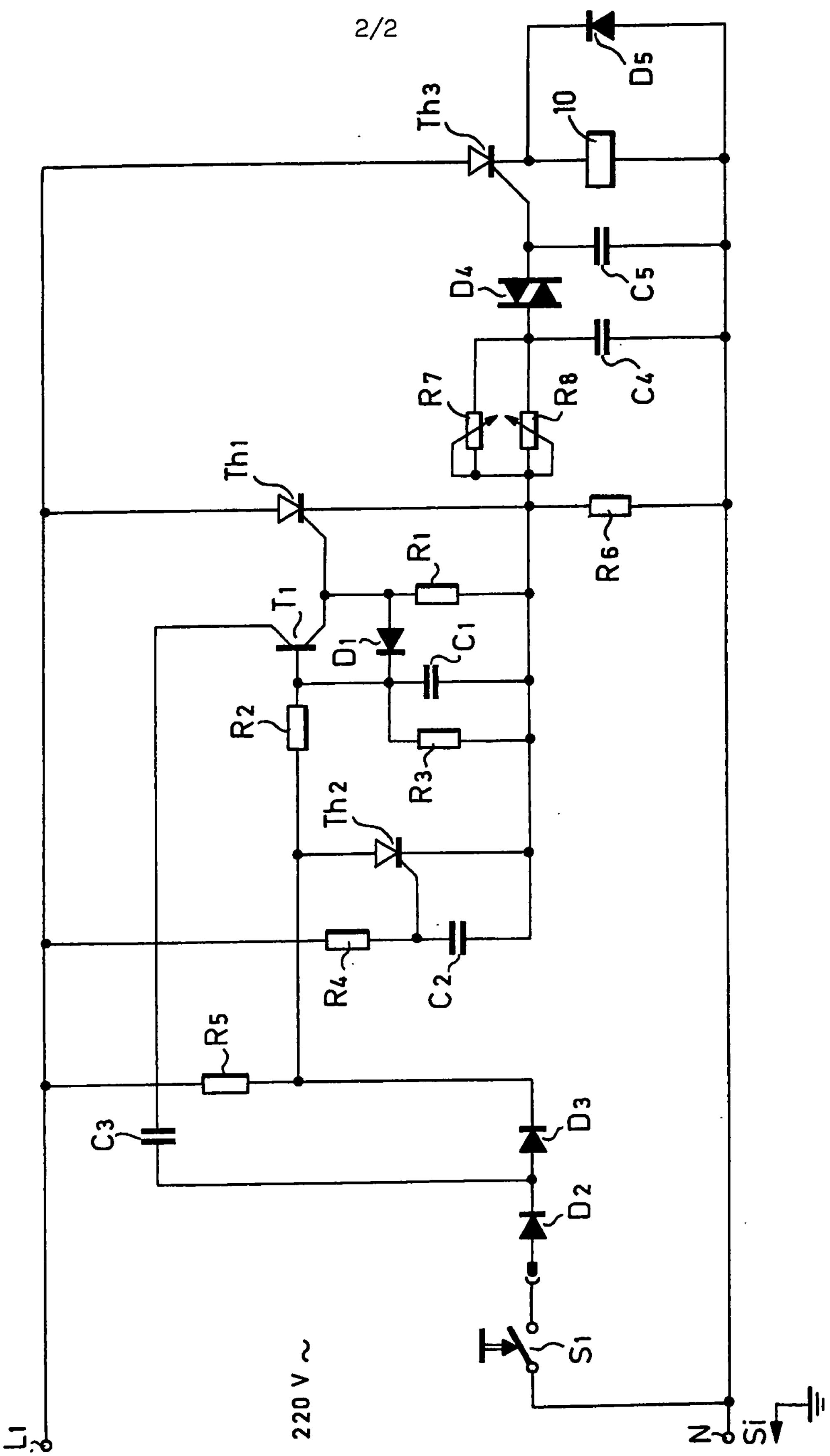


FIG.3



F I G. 2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220 V ~
N
Si
S1
D2
D3
C3
R5
R4
C2
Th2
R2
R3
D1
C1
T1
R1
Th1
R6
R7
R8
C4
D4
C5
Th3
10
D5

SPECIFICATION

Circuit arrangement for an electric drive-in apparatus

The invention relates to a circuit arrangement for an electric drive-in apparatus for beating in nails, staples or the like, comprising a magnet coil connected to an a.c. voltage via a power switch, a control stage connected to the a.c. voltage source and comprising a push-button switch, said control stage generating a switch-on pulse for the power switch when the push-button switch is actuated.

The basic construction of an electric drive-in apparatus has been known for a relatively long period of time (German Patent Specification No. 1,478,899). The drive-in plunger for the nails or staples is a component of a ferromagnetic plunge anchor or is formed by it, being drawn into a magnet coil when the latter is connected to a voltage source. A readjusting spring takes care of the return movement of the drive-in plunger into the position of rest, when the magnet coil has been switched off.

It has furthermore become known to perform the triggering of the magnet coil with the aid of a power thyristor. The power thyristor is connected in series with the magnet coil to an a.c. voltage. The control electrode of the power thyristor is triggered with the aid of a pulse circuit via another thyristor and the power thyristor is triggered when the key of the drive-in apparatus is actuated (German laid-open Specification No. 2,238,440).

With the known drive-in apparatus it has to be considered to be a disadvantage that the striking force made available is essentially constant. The striking force available is governed by the magnet coil used and the plunge anchor being employed and thus cannot be increased for a given apparatus. There are, however, many cases of application in which a smaller drive-in power is desired, in order to keep damage at the surface of the workpiece at a minimum, for example. In order to do justice to all cases of practical application, it is necessary to make available a series of drive-in apparatuses of varying striking forces.

The invention is based upon the problem of providing an electric drive-in apparatus for nails, staples or the like, in which the driving force may be adjusted to different values.

With a drive-in apparatus of the type as mentioned at the beginning this problem is solved in that an auxiliary control stage is provided having a zero-axis crossing detector and providing an auxiliary control pulse to the control stage only when a positive or negative half-wave just passes through zero or has passed through zero, when the auxiliary control pulse is in phase with the a.c. voltage and the control stage contains a time delay stage by means of which the switch-on pulse may be timely delayed with respect to the auxiliary control pulse.

The invention is based on the assumption that a half-wave is switched on to the magnet coil via the power switch when maximum striking force is demanded. If the power switch is opened to a certain degree after the half-wave has pased through zero, then, there will be available to the magnet coil still only the remainder of the half-wave with the result that the drive-in energy is reduced by this amount.

The operator upon actuation of the key of the drive-in apparatus, of course, cannot know how the phase situation of the a.c. voltage is at this moment. Therefore, a zero-axis crossing detector is provided which prevents the transmission of a switch-on pulse to the power switch if, at the moment at which the key of the drive-in apparatus is switched on, the a.c. voltage is somewhere between the zero-axis crossings. Only with the following zero-axis crossing will the switch-on pulse be activated via the auxiliary control pulse stage, in order to close the power switch. It is then possible with the aid of the time delay stage to displace the switching point of the closing of the power switch and thereby change the striking power of the drive-in apparatus, namely from zero to maximum striking power infinitely variably.

In this manner it is possible to beat in nails with one and the same drive-in apparatus even in very delicate materials without damaging them. It is for instance possible with the aid of the drive-in apparatus according to the invention to drive staples into soft wood of 4 mm as well as also into soft wood of 18 mm without having to fear any damage.

In one embodiment of the invention provision is made that in the control stage a half-wave is transmitted onto the time delay stage. It goes without saying that the half-wave pulse which is transmitted onto the time delay stage by the control stage is in phase with the a.c. voltage at the power switch. In this manner it is easily possible through an RC section with variable resistance to vary the triggering point of time of the power switch.

The teaching of the invention may be realized with various circuit arrangements. One advantageous embodiment of the invention provides in this respect for the control stage to comprise a thyristor connected across an a.c. voltage with its control electrode adapted to be connected to a firing capacitor via a controllable electronic switch, the zero-axis crossing detector likewise comprising a thyristor having its control electrode connected to the a.c. voltage source in such a manner that the second thyristor will be switched through immdiately after zero crossing and will inactivate the control input of the controllable switch. The controllable electronic switch with the key actuated will transmit a pulse onto the first thyristor so that it will ignite the power thyristor. The second thyristor, however, takes care that the electronic switch is blocked when at the moment the key is actuated the half-wave of the a.c. voltage is somewhere between the zero crossings. Only when the half-wave (positive or negative) has reached the next zero crossing or is a short way past it will the electronic switch allow ignition of the first thyristor.

According to another embodiment it is provided that the controllable switch is a transistor having its base connected both to a pole of the a.c. voltage source and an electrode of the second thyristor, while its emitter-collector section is connected to the control electrode of the first thyristor.

Some examples of embodiment of the invention will be described in the following in more detail by way of the accompanying drawings, in which:

Figure 1 shows a block diagram of a circuit arrangement according to the invention;

Figure 2 shows a more detailed constructional design of a circuit arrangement according to the invention; and

Figure 3 shows some diagrams to explain the function of the circuit arrangement according to Figure 2.

Prior to enlarging in more detail on the details shown in the drawings let it be stated that each of the features described is of inventively essential significance by itself or in connection with features of the claims.

In Figure 1, 10 designates the magnet coil of a conventional electric drive-in apparatus which for the rest is not shown in the drawings. The magnet coil 10 is connected to an a.c. voltage source 12 via a power switch 11. A switch-on pulse stage 14 is connected to the a.c. voltage source 12 in series with a key 13 of the drive-in apparatus (not shown). The switch-on pulse stage 14 provides pulses to a time delay stage 15 which for its part triggers the power switch 11. The switch-on pulse stage 14 for its part is activated by an auxiliary control stage 16 which for its part is triggered by a zero-axis crossing detector 17.

The circuit arrangement according to Figure 1 operates as follows: If the key 13 is closed, the switch-on pulse stage 14 will transmit a switch-on pulse onto the power switch 11, in order to close it and connect the magnet coil 10 to a voltage. In this operation the power switch is opened only for one half-wave of the a.c. voltage and then will close again. The auxiliary control pulse stage 16, however, prevents the switch-on pulse for the power switch being given at any arbitary point of time. Rather, the zero-axis crossing detector takes care that a switch-on pulse is transmitted onto the power switch 11 only when the a.c. voltage just passes through zero is or has just passed through zero. At a certain distance from the preceding zero crossing the switch-on pulse stage will be blocked, and the power switch 11 remains opened. Only with the following zero crossing will the zero-axis crossing detector activate the auxiliary control pulse stage 16 which for its part activates the switch-on pulse stage 14 in order to close the power switch 11. The time delay stage 15, however, passes the switch-on pulse on to the control input of the power switch 11 respectively delayed according to the adjustment, so that the closing of the power switch may be changed with respect to the reference zero crossing of the a.c. voltage. Correspondingly, either an entire half-wave or only part of it may be connected to the magnet coil 10 via the power switch 11.

In Figure 2 the magnet coil is likewise referenced 10. The key, however, is characterized by S 1. The magnet coil 10 is connected to the a.c. voltage source L1/N in series with a power thyristor Th 3. A parallel connection consisting of a variable resistor R7 and a potentiometer R 9 is series connected to a Triac D4 and connected to the control electrode of the power thyristor Th3. One terminal of a capacitor C 4 is connected to a point between the resistor parallel connection and the triac, the other terminal of said capacitor being connected to the pole N. Behind the triac there is another capacitor C 5 connected in parallel with the capacitor C 4. An idle diode D 5 is connected in parallel with the magnet coil.

A series connection consisting of a thyristor Th 1 and a resistor R 6 is connected to the voltage source in parallel with the series connection of the thyristor Th 3 and the magnet coil 10. A point between thyristor Th 1 and a resistor R 6 at the voltage source between the thyristor Th 1 and the resistor R 6 is connected to the resistor parallel connection R 7/R 8. The control electrode of the thyristor Th 1 is connected to the emitter of a transistor T 1 the collector of which is connected via a capacitor C 3 to a connection point between two series connected diodes D 2 and D 3. The diode D 2 has the other electrode thereof connected to the pole N via the key S 1. The basis of the transistor T 1 is connected to the pole L 1 via the series connected resistors R 5 and R 2. A series connection consisting of a resistor R 4 and a capacitor C 2 is connected to the a.c. voltage source in series with the resistor R 6. Another thyristor Th 2 has one electrode thereof connected to a point of junction between the resistors R 5 and R 2, while the other electrode thereof is connected to a point of junction between thyristor Th 1 and resistor R 6. The control electrode of the thyristor Th 2 is connected to a point of junction between the resistor R 4 and the capacitor C 2.

A resistor R 1 is connected between the emitter of the transistor T 1 and the control electrode of the thyristor Th 1, said resistor having the other pole thereof connected to a point of junction between the thyristor Th 1 and the resistor R 6. A diode D 1 is connected to a point of junction between the emitter of the transistor T 1 and the resistor R 1, the other electrode thereof being connected to the one terminal of a parallel connection consisting of a resistor R 3 and a capacitor C 2 which for the rest is connected to a point between the resistor R 2 and the base of the transistor T 1. The other terminal of the parallel connection R 3, C 2 is likewise connected to a point of junction between the thyristor Th 1 and the resistor R 6.

The circuit arrangement according to Figure 2 operates as follows: Transistor T 1 receives its base current via the resistors R 5 and R 2. As, however, the thyristor Th 2 is fired by means of the R/C section R 4-C 2 at the beginning of the half-wave, it will switch off the control voltage for the transistor T 1. If, thus, the key S 1 is depressed at any point of time between the zero crossings of a half-wave, the pulse provided from the capacitor C 3 to the collector of the transistor T 1 will be unable to effect anything, i.e. the thyristor Th 1 remains unfired. If the key S 1 remains depressed a pulse may now be transmitted from capacitor C 3 via the collector-emitter section of transistor T 1 to the control electrode of the thyristor Th 1, because during the zero crossing or immediately thereafter there is still a control voltage connected to the transistor T 1. Thus, the thyristor Th 1 is

fired only at the beginning of a half-wave and allows it entirely to pass through. The voltage at resistor R 6 via the trigger circuit consisting of the capacitors C 4 and C 5 and the Triac D 4 serves to fire the power thyristor Th 3 which then connects the magnet coil 10 to a voltage. The point of time of firing the thyristor Th 3 may be adjusted by varying the resistor R 8 in order to adjust the output of the magnet coil 10 per half-wave and thus the desired striking force.

The variation of the striking force becomes especially clear from the diagram according to Figure 3. The top diagram shows the curve followed by the voltage of the a.c. voltage source L 1/N. The representation there-beneath marks the point of time when a key is depressed. The positive half-wave following this is allowed to pass through from the thyristor Th 1 onto the resistor R 6 on the ground of the functional runoff as described above. This may be recognized from the representation in the diagram which shows the voltage U R6 dropping at the resistor R 6. As already explained, however, the point of time of firing the power thyristor Th 3 may be changed, i.e. between full half-wave and zero. This is explained in the bottom diagram according to Figure 3, representing the progress of the voltage at the magnet coil 10 within a given time.

CLAIMS

1. A circuit arrangement for an electric drive-in apparatus for beating in nails, staples or the like, comprising a magnet coil for connection to an a.c. voltage via a power switch, a control stage comprising a key for connection to the a.c. voltage source, said control stage with the key actuated generating a switch-on pulse for the power switch and an auxiliary control stage including a zero-axis crossing detector which transmits an auxiliary control pulse in phase with the a.c. voltage onto the control stage only when a positive or negative half-wave of the a.c. voltage just crosses zero or has just crossed zero, the control stage containing a time delay stage by means of which the switch-on pulse may be delayed in time vis-a-vis the auxiliary control pulse.

2. The circuit arrangement according to claim 1, wherein the control stage is arranged to transmit a half-wave pulse onto the time delay stage.

3. The circuit arrangement according to claim 1 or 2, wherein the control stage comprises a first thyristor for connection to the a.c. voltage, the control electrode of which is adapted to be connected to a firing capacitor via a controllable electronic swich, the zero-axis crossing detector likewise comprising a second thyristor the control electrode of which can be connected to the a.c. voltage in such a manner that the second thyristor is switched through directly after the zero crossing and inactivates the control input of the controllable switch.

4. The circuit arrangement according to claim 3, wherein the controllable switch is a transistor the base of which can be connected to a line carrying the a.c. voltage as well as to an electrode of the second thyristor, while the collector-emitter section thereof is connected to the control electrode of the first thyristor.

5. A circuit arrangement substantially as hereinbefore described with reference to the accompanying drawings.

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